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Science and Technology for Tomorrow's Aerospace Forces

Success Story

CONTINUOUS MOLDLINE TECHNOLOGY

Continuous Moldline Technology (CMT) offers substantial performance payoffs for numerous applications. Variable geometry fuel cells and inlets are two notable examples where CMT can reduce aerodynamic drag throughout a mission profile and, therefore, extend the range of the vehicle.

In addition, application of CMT to bridge the gap between movable control surfaces and fixed wing structure improves the aerodynamic effectiveness of the control surface and can reduce the noise generated by the unsealed gap. Eliminating the moldline discontinuities around the deflected surface also eliminates effectiveness losses associated with aerodynamic gap spillage and reduces flow separation.

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Accomplishment

Air Vehicles Directorate engineers recently conducted a flight demonstration of CMT—an innovative structural concept that uses highly flexible materials to enable in-flight modification of airframe geometry. CMT consists of an elastomeric matrix, reinforced with stiffening rods that are able to slide within the matrix to achieve very high deformation.

In order to validate the flight worthiness of this flexible structure, the team modified the trailing edge of the National Aeronautics and Space Administration's (NASA's) F-15B Flight Test Fixture to subject a CMT structure to the full operational envelope of the test aircraft. The flights covered the operational envelope of the test aircraft, testing the CMT structure up to Mach 1.7, dynamic pressures up to 990 psf, and altitudes from 5,000 to 40,000 ft.

The team obtained aerodynamic pressures and CMT structural response data for deflections of the CMT surface up to 30°. Preliminary inspections of the CMT structure reveal no signs of wear or damage after the five hours of flight tests.

Background

Adaptive airframe structures would enable in-flight modification of vehicle geometry (morphing) and allows for air vehicle designs that can perform more effectively over a wide range of flight conditions and for multiple missions. While it is easy to see how an adaptive structure can improve aerodynamic performance, the key to realizing these aerodynamic benefits on an air vehicle is to minimize any penalties associated with the adaptive structure versus a conventional structure. Weight, cost, and actuation power requirements are all potential penalties that could limit the effectiveness of CMT applications.

While the basic CMT structural design concept is generic to various applications, directorate researchers chose the continuous control surface application as the initial focus due to availability of experimental test assets. Prior to the flight demonstration, the team conducted a wind tunnel demonstration of a continuous control surface on a scaled fighter aircraft model in a low-speed tunnel at NASA Ames Research Center.

A continuous control surface uses CMT along the hinge line and as a transition between fixed structure and the actuated surface. The team performed an analysis of test environments, cost, and data collection possibilities and identified the NASA F-15B Flight Test Fixture as the best test bed for continuing the development of CMT.

Air Vehicles
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (02-VA-01)